Design of Hydroponics System for Remote Automation

B S Shubhashree
Student: Dept.of ECE
GSSSIETW, Mysuru
Karnataka, India

Divya D
Student: Dept.of ECE
GSSSIETW, Mysuru
Karnataka, India

Harsha Mohan Hiremath
Student: Dept.of ECE
GSSSIETW, Mysuru
Karnataka, India

Jyothi T U
Student: Dept.of ECE
GSSSIETW, Mysuru
Karnataka, India

Mr Yashonidhi Yajaman
Assistant Professor
Dept.of ECE, GSSSIETW
Mysuru

***Abstract*— Scientists estimate that by 2050 Earth's population increases rapidly, and lands available for cultivation declines. In order to combat the above said situation it is of major importance to promote farming in each and every person globally. Hence, the system is designed to support farming in the available area such as roof tops, balconies, and in small office spaces using technique called hydroponics. In our proposed research work, effort has been made to use IoT devices to monitor pH and air quality index, followed by alarming the user when their farm is in abnormal condition. An android application has been developed to track, update and control the performance of IoT devices used in the system.**

Keywords— Hydroponics, IoT, Air Quality Index, pH, Android Application.

I. INTRODUCTION

Hydroponics is defined as the process of growing plants in the water medium. The essential nutrients required for the growth of plants are supplied through the nutrient solution in which the roots are dipped; the nutrient solution can be either static or flowing. The Hydroponics technique dates back to the ancient times where Babylonians used this method for hanging gardens. [1] An alternative to soil is porous growing aggregate such as sand, gravel, coir, clay and perlite. These materials allow the air and nutrient to freely pass through them hence enabling even distribution of oxygen and food to each plant. [2] Different types of hydroponics techniques include deep water culture, aeroponic system, ebb and flow, nutrient film technique and wick system. The most prominent ones are deep water culture and nutrient film technique. In deep water culture the roots are allowed to absorb the nutrient in the water solution for its efficient growth. [3] Growth of plants in the hydroponics system depends on several environmental factors such as amount of light, pH and conductivity of the solution, oxygenation, salinity and air humidity.

The growth of hydroponics plants, especially vegetable crops, are affected by factors such as change in electrical conductivity in nutrients, pH, light intensity, air and water temperature. The high-quality vegetable crops can be produced by maintaining the factors that affect the hydroponics plants. The plant growth ceases to be optimal if the hydroponics system is not monitored regularly and periodically. This affects the yield of the plants [4]. The good or bad contents of air inside a building is referred as Indoor Air Quality (IAQ). The physical reaction, health, work performance and comfort of a building occupant can be affected by IAQ. The IAQ is termed to be good only if it does not exceed certain level. The physical factors like dust particles, biological factors like molds and bacteria growth, and chemical or gaseous pollutants can influence the IAQ to be good or bad [5].

In the proposed system flow rate, pH and air quality sensors are used to measure different parameters. Flow rate sensor is used to measure the total amount of water and nutrient solution that is required in the hydroponics system to maintain the set pH value which is measured by the pH sensor, the system mainly focuses on automatically maintaining the pH value of the solution in reservoir by comparing the sensed value and the fetched value from the Blynk app. The air quality of the surrounding in which the system is installed is continuously monitored by the air quality sensor. A buzzer is also used to alarm the user when the air quality index is not equal to the threshold value set by the user. Blynk application which is developed in the users Smartphone is used to set the total amount of solutions, pH and AQI values required and the sensed value is sent back to the application hence enabling remote monitoring of the system.

II. LITERATURE REVIEW

Looking into the current situations of hydroponics farming, few solutions which are available are under research developments. There were some limitations and drawbacks in those, so this solution tries in overcoming the current problems with certain different approach.

Many systems have been proposed to automate hydroponics, [6] has presented a system which consists of controller for automation, a control panel and for wireless monitoring and control of the system, a highly integrated mobile application. The research paper [7] suggested that instead of prematurely discarding the nutrient solutions, their lifespan can be increased using simple procedural changes like decreasing the environmental impacts and the production costs. Paper [8] proposed a smart farming system in an enclosed, limited area where required sensors are positioned to measure parameters such as temperature, moisture content, light intensity, pressure and pH of the soil. This system can be set up at minimum cost by an individual. Thus, by providing the favorable environmental conditions for plants, the productivity has been enhanced. Hydroponic Farming Ecosystem (HFE) which uses IoT devices to monitor nutrient solution, humidity, temperature, air temperature, Electrical Conductivity (EC) and pH has been discussed in [9].

Design of cost-effective hydroponics system has been discussed in [10], which focuses on improving the quality of plants by reducing the usage of pesticides and providing proper nutrients to the plants by using suitable technology. A method proposed in [11] effectively utilizes data in real time to control the performance of devices used in the system. Main aim of the work was to build an automated system which is self-controlled by using present technology. The system [12] concentrates on growing multiple crops with the help of single controller using the concept of embedded systems. Supplements for the hydroponics plant is provided based on the data of pH and water level sensor. An efficient algorithm developed facilitates flow of water and nutrients to the plant at controlled interval of time. The proposed methodology [13] aims to develop a tool using Arduino uno microcontroller and a dedicated smart phone. The developed tool uses a technology to continuously monitor the flow of nutrients to the plant, device can also send data of temperature and fluid level around the plant to the user. User can view these data using smart phone.

III. PROPOSED METHODOLOGY

The proposed methodology is implemented according to the block diagram as shown in Fig.1. As the device powers up, the following operations takes place. The reservoir tank is supplied with required amount of water and nutrients using DC motor, their flowrate is monitored using flow rate sensor. The water and nutrient solution are mixed in the reservoir tank and the solution thus obtained is measured for its pH. The user can set value of reference pH using Blynk app, set value will be stored in the Blynk cloud.

The connection between the controller and the server is established using Wi-Fi module (NodeMCU). The measured pH is compared with reference pH value. If the pH of the solution in reservoir tank is same as the reference pH then, the solution is flowed into the hydroponics tank using DC motor. Otherwise, the pH of the solution is adjusted by adding water or nutrients from the respective tanks. Now, the solution with desired pH value is flowed into the hydroponics tank with controlled flow rate, using DC motor.

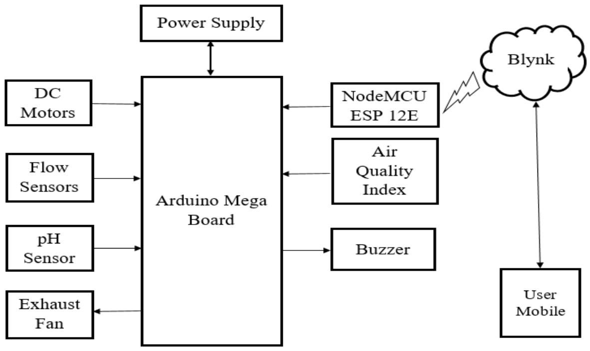

Fig.1. Block diagram of Hydroponics System

After certain iterations if the pH of the solution in the reservoir tank continues to be acidic then, the solution is drained out, the process terminates and the cycle begins from the initial step. After certain delay, the solution from the hydroponics tank is flowed back to reservoir tank through DC motor. The flow of the system is as shown in Fig.2.

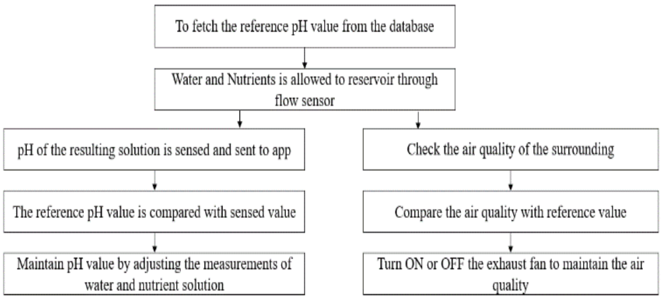

Fig.2. Flow diagram of the proposed system

One of the major factors for the plant's growth is the composition of air. Different gases such as carbon dioxide, nitrogen, nitrogen dioxide, etc., help in efficient growth of the plant, hence the system measures the air quality. If air quality level is not up to the mark with certain threshold associated with sensor, then the exhaust fan is switched ON to maintain the balance in air composition. The above cycle repeats.

The values of flow rate sensor, pH sensor and air quality index sensor are sent to the app through Wi-Fi module. Flow rate sensor and air quality index sensor values can be viewed by the user whereas the pH value can be set based on the requirements in android app.

Here, case study has not been taken with respect to a plant since the proposed system concentrated on working with the electronics associated in hydroponics to ensure reliable control and monitoring mechanism for plant growth.

IV. RESULT

The image shows the Blynk app screen where different parameters such as measured pH sensor value, air quality index value and the total intake of water being flown into the reservoir tank. It also shows the vertical slider for adjusting the pH value according to the user's requirement. The recorded values can be plotted in a graph to understand the nature of the system.

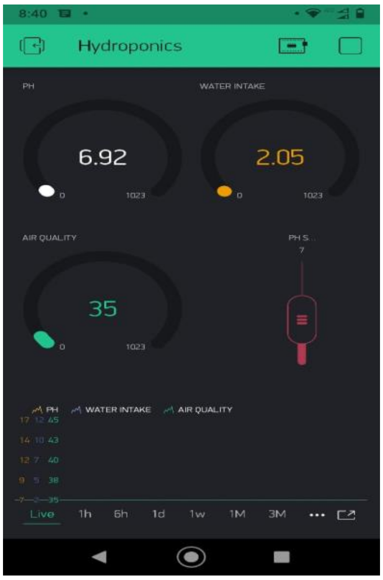

Fig.3. Button Widgets for Different Parameters

Fig.4. Graph of various parameters

V. CONCLUSION AND FUTURE SCOPE

We are able to demonstrate the scenario to show how to maintain pH level in a reservoir by regulation of flow rate of nutrients and water, parallelly monitoring the air quality of the environment by even accounting sudden disruption to ensure preferable environment for plant growth.

In proposed system, the measured pH value always tries to cope up with the reference pH value by considering calibrations of pH sensor as a prime factor. The values obtained from flow sensors, pH sensor and air quality index sensor are sent to the app through a Wi-Fi module, to enable the user to track performance remotely.

Designed system is able to monitor and control pH and air quality, rest of the factors such as temperature, humidity and EC are not considered. These might play a vital role in promoting efficient plant growth. To overcome this the controller needs to be interfaced and calibrated with various sensors supporting the above said factors. The motors used in the system can be replaced by PWM for more precision. Air quality index sensors can be along with the formaldehyde sensor to detect accurate variations in air quality. Further artificial intelligence can be used to make the system self-reliant so that it can analyze the conditions, requirements and act accordingly

ACKNOWLEDGMENT

We extend our heartfelt gratitude to our institution GSSS Institute of Engineering and Technology for Women, for their extensive support and a great exposure which helped us to accomplish this project, it has also helped us to understand and develop various skills and upgrade ourselves.

REFERENCES

[1] Dr D.Saraswathi, P.Manibharathy, R.Gokulnath, E.SureshKumar, K.Karthikeyan, "Automation of Hydroponics Green House Farming using IOT", 2016 IEEE International Conference on System, Computation, Automation and Networking(ICSCA)

[2] Chris Jordan G. Aliac, Elmer Maravillas, "IOT Hydroponics Management System", 2018 IEEE 10th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management (HNICEM)

[3] Saaid M.F, Sanuddin A, Megat Ali, I.M Yassin, "Automated pH Controller System for Hydroponic Cultivation", 2015 IEEE Symposium on Computer Applications and Industrial Electronics(ISCAIE)

[4] Baihaqi Siregar, Syahril Efendi, Heru Pranoto, Roy Ginting, Ulfi Andayani, Fahmi Fahmi, "Remote Monitoring System for Hydroponic Planting Media", 2017 The International Conference on ICT for Smart Society(ICISS)

[5] Shaharil Mad Saad, Abdul Rahman Mohd Sad, Azman Muhamad Yusof Kamarudin, Ammar Zakaria, Ali Yeon Md Shakaff, "Indoor Air Quality Monitoring system using wireless sensor network(WSN) with web interface", 2013 International Conference on Electrical, Electronics and System Engineering(ICEESE)

[6] Akeem Liburd, Matthew LaRue, Joseph Johnson IV, Joseph Bender, "Smart Hydroponic System", University of Central Florida, 2014.

[7] Emerson Christie, "Water and Nutrient Reuse within Closed Hydroponic Systems", Georgia Southern University, Spring 2014

[8] R.Ramya, C.Sandhya, R.Shwetha, "Smart Farming Systems using Sensors", 2017 IEEE International Conference on Technological Innovations in ICT For Agriculture and Rural Development (TIAR 2017)

[9] Somchoke Ruengittinun, Sitthidech Phongsamsuan, Phasawut Sureeratanakorn, "Applied Internet of Thing for Smart Hydroponic Farming Ecosystem(HFE)", 2017 International Conference on Ubi-media Computing and Workshops

[10] Shreya Tembe, Sahar Khan, Rujuta Achareka, "IoT based Automated Hydroponics System", International Journal of Scientific & Engineering Research, Volume 9, February 2018

[11] Saket Adhau, Rushikesh Surwase, KH Kowdiki, "Design of Fully Automated Low Cost Hydroponic System using Labview and AVR Microcontroller", 2017 IEEE International Conference on Intelligent Techniques in Control, Optimization and Signal Processing

[12] Mitali V. Shewale, Devendra S.Chaudhari, "IoT based Plant Monitoring System for Hydroponics Agriculture: A Review", International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 6, February 2018

[13] P Sihombing, N A Karina, J T Tarigan, M I Syarif, "Automated Hydroponics Nutrition Plants Systems using Arduino Uno Microcontroller based on Arduino", 2nd International Conference on Computing and Applied Informatics 201

[14] Yakub Eka Nugraha, Budhi Irawan, Randy Erfa Saputra, "System Design and Implementation Automation System of Expert System on Hydroponics Nutrients Control using Forward Chaining Method", The 2017 IEEE Asia Pacific Conference on Wireless and Mobile

[15] Naru Jai, Balaji Dontha, Amiya Tripathy, S.S.Mande, "Near Real Time-Sensing System for Hydroponics based Urban Farming", 2018 3rd International Conference for Convergence in Technology